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[REDACTED]
FY-67 Quarterly Report No. 2

PAR 245

30 Nov 66

SUBJECT: BPE High-Magnification Lens Sets

TASK/PROBLEM

1. Design, fabricate, and test prototype optical systems to extend the Briefing Print Enlarger (prototype) PAR 243A upper limit magnification range from 60X to 140X - 160X.

DISCUSSION

2. The optical designs of the two objective lenses and of the mating condensers were completed during the quarter.

3. For the 95X to 153X requirement (Lens Set "H"), a seven-piece N-type lens with $f/2.2$ relative aperture was designed to meet the contractor's in-house Specification 469-334. The condenser is of three-piece design having only glass elements with spherical surfaces.

4. In the design of the 60X to 97X lens (Lens Set "G"), the optical designers encountered excessive oblique spherical aberration. Four different arrangements of elements were explored using the design optimization programs and evaluated according to computed ray-trace data.

a. The first arrangement evaluated was a scaled-down version of the seven-element design of the 40X to 60X lens for the BPE (Lens "F") with the relative aperture adjusted from $f/2.8$ to $f/2.6$. Design performance was just under the specification for design goals over most of the required field.

b. Two eight-element lenses were tried. These were acceptable everywhere in the field except in the range of 16° to 18° semi-field angle.

c. In an attempt to improve the performance at 18° , a nine-element lens was designed. This design was better everywhere except in the 16° to 18° range.

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The failure of these lenses to meet the design goal performance at 90 percent energy level at 18° semi-field angle is due to sagittal oblique spherical aberration which cannot be reduced without losing image quality at the smaller field angles.

5. The best optical design among those explored for the 60X to 97X range, judged on the ray-trace prediction of performance and its manufacturability, is one of the eight-element designs. For field angles of 16° to 18° , it is expected to deliver 80 percent of the energy into a specified circle rather than the design goal of 90 percent. The design achieves the design goals for the majority of the angular field and the compromise of image quality at the extreme edges of the field appears relatively minor. At 60X, the area in the specified rectangular 20- x 24-inch print beyond 16° is about 3.6 percent of the total picture area. At magnifications above 66X, the field angle required to cover a 20 x 24 print is 16° or less. The best means of judging the image quality in such a case is examination of prints exposed with a sample lens. Work is proceeding on the design and fabrication of the completed eight-element optical design to allow such testing.

6. On 9 November, a visit was made by the customer's representatives to discuss this project and others under the contract. The problems encountered in the 60X to 97X lens design were discussed and the representatives concurred in the contractor's planned fabrication of sample lenses and focusing assemblies. All of the optical designs have been released for engineering design and sample fabrication.

7. It was found possible to use the available Focus Assembly design for the 40X to 60X lens (Lens "F") for both of the new High-Magnification-lenses. The contractor has requested a review of the estimate of the fabrication cost of the Focusing Assemblies before releasing the designs for fabrication for this project.

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PLANNED ACTIVITY

8. In the next quarter, the engineering designs for the optics will be completed and all parts released for fabrication.

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